REMARKS

Status of Claims

Claims 1 – 28 were original in the application. Claims 1 – 18, 20, 21, and 26 - 28 have been currently amended. Claims 1 – 28 are submitted for examination on the merits.

Objection to Claims

The Examiner has objected to claims 11 and 25 as being directed to a resonant gyroscope, while dependent on claims directed to a nonresonant gyroscope. The reference in claims 11 and 25 to a "resonant frequency of an isolated passive mass-spring system" does not mean that the gyroscope as a whole is driven at resonance. As the Examiner states at paragraph 3 in objecting to claim 1, "everything has a resonance". Without endorsing this statement, applicants respectfully submit that a component of a gyroscope may have a resonance, but it does not mean that the gyroscope is driven or operates at that or any other resonance.

The applicants have removed "nonresonant" from the claims and substituted in claim 1 "operated in a nonresonant mode", thus rendering the objection moot that even a nonresonantly operated gyro could still be resonant. Claims 11 and 25 thus include limitations on a gyro which is not labeled as a "nonresonant gyro".

The Examiner further objected to the various references to "proof mass" and "mass". The word, "proof", has been deleted from the claims, thus removing the basis for objection.

The Examiner still further objected to the drive mode oscillator and sense mode oscillator of claim 1 as being composed of the same elements. Claim 1 makes no such definition of the drive mode oscillator and sense mode oscillator. Claim 1 states that the drive mode oscillator and sense mode oscillator employ three interconnected masses. It does **not** follow that the remaining elements of the drive mode oscillator and sense mode oscillator are the same. As stated in the last amendment as shown schematically in Fig. 2 the first mass moves only in the drive direction. The second and third masses move together in the drive direction and move independently of each other in the sense direction. Thus, the drive mode oscillator comprises an element which drives the first, second and third masses in the drive direction. The sense mode oscillator comprises an element which sense the second and third masses in the sense direction. The structure that drives is not the same as the structure that senses.

The Examiner objects to claim 2 for failing to further limit what coupling constants are chosen. The specification describes the coupling constants in the equations. Nonetheless, the reference to "coupling constants" has been deleted rendering the objection moot.

The Examiner objects to claim 3 on various grounds, which have been largely met by amendment. The Examiner contends that the intermediate mass does not generate the Coriolis force, but is acted upon by it. Coriolis force arises by virtue of a mass moving in an accelerating frame. The Coriolis force does not arise from an outside source to be apply to a mass like an electrostatic force from source external charges. The Coriolis force arises or is generated from the existence in an rotating reference frame of the very same mass to which the force is applied. If the object had

no mass, there would be no Coriolis force. Hence, the mass is the origin of the Coriolis force. Therefore, it is correct to state that the Coriolis force "generated by means of the enlarged intermediate mass results in larger Coriolis forces for increased sensitivity".

Claim 4 has been responsively amended.

The Examiner objects to claim 5 in that the second mass "is the sense mode oscillator." It is not clear on what basis the Examiner finds the definition of the invention objectionable. Insistence on forcing the definition of the invention into conventional constructs is not a valid basis of objection. The second mass is recited as moving in the sense direction. Fig. 2 illustrates the system. The third mass also moves in the sense direction. The third mass acts as a vibration absorber of the motion in the sense direction caused by the motion of the second mass in the sense direction. The input angular rate is measured from movement of the third mass in the sense direction. Traditional characterizations of disjoint structures being "in" the drive or sense oscillator are not useful in the definition of the present invention, which is better defined in direct terms of the masses and their movements.

Claims 6 and 7 have been responsively amended.

Use of "wherein" in claim 9 is appropriate and no reason has been provided for its deletion.

Claim 11 has been responsively amended.

In regard to claim 12, the three interconnected masses have been recited as separate elements from the oscillators. Determining which masses are "part of" which oscillators is not a helpful construct since the first, second and third masses are "part of" of the drive-mode oscillator and the second and third masses are "part of" of the sense-

mode oscillator. The first, second and third masses are collectively the driving mass in the drive-mode oscillator. The second and third masses are collectively the driven mass in the drive-mode oscillator. The second mass is the driving mass in the sense-mode oscillator. The third mass is the driven mass in the sense-mode oscillator. The Examiner creates confusion by insisting that each of these masses be "part of" only one or other ones of the oscillators. The illustrated embodiment is a nested gyro in the sense that there are two oscillators and one oscillator is nested in the other. Requiring "parts" of oscillators to be separately delineated in a nested gyro is not useful conceptualization and should not be artificially imposed on the claims. Claim 12 has otherwise been responsively amended.

Claim 14 has been responsively amended. The basis of the objection cannot be understood in the statement "Further, it is not clear which flexures are recited because only the flexure coupled to the third mass is coupled to the second mass." There is no statement that "the flexure coupled to the third mass is coupled to the second mass".

Claim 15 has been responsively amended. The drive and sense mode oscillators are mechanically coupled to each other, but their motions are independent. The drive oscillator moves in a manner according to the driving force applied to it as in a conventional gyro. The sense oscillator moves in a manner as determined by the acceleration of the gyro and its motion is in this sense decoupled from the drive oscillator. However, the sense oscillator is not driven by an external electrostatic force as in the case of the drive mode oscillator, but by means of the motion of the second mass which in turn is driven by the drive mode oscillator. However, the resonances of

the various masses and their coupling flexures are chosen to dynamically decouple the motions of the sense and drive mode oscillators.

Claim 16 states: "driving the drive-mode oscillator and driving the sense-mode oscillator dynamical amplifies motion in the drive and sense directions." The objection that what motion is being amplified is not stated is untrue. The motion in the drive and sense directions is amplified.

Claims 17, 18, 20, 21, 24, 26 and 28 have been responsively amended.

Rejection Pursuant to 35 USC 112

Much of the basis of rejection under section 112 relates to a misconception of what is meant by "decoupling" the drive and sense mode oscillators. Clearly there are mechanical or physical connections between them.

Paragraph [005] states:

> In the illustrated embodiment of the invention, we propose a micromachined gyroscope system utilizing dynamical amplification to achieve large oscillation amplitudes without resonance, while mechanically **decoupling the drive direction oscillations from the sense direction oscillations**.

The **oscillations or motions** in the drive direction are decoupled from those in the sense direction. This is sometimes referred to in a shorthand way as mechanically decoupling the oscillators as is common in the language usage in the relevant technology. It is clear that the specification shows flexures connecting all of the masses and therefore it does violence to insist that mechanically decoupling refers to physical connection and not to decoupling of the oscillations through mechanical means, i.e. choice and relationship of resonances, antiresonances and flexure restrictions on motion. These are characteristics determined by mechanical parameters.

Paragraph [114] states:

> The overall system 10 utilizes dynamical amplification in the drive and sense directions to achieve large oscillation amplitudes without resonance resulting in increased bandwidth and reduced sensitivity to structural and thermal parameter fluctuations and damping changes, **while mechanically decoupling the drive direction oscillations from the sense direction oscillations** leads to improved robustness and long-term stability over the operating time of the device.

What this is stating is that the oscillations in the drive direction are not directly reflected in the oscillations in the sense direction. Instead, the oscillations in the sense direction reflect the acceleration to which the gyro is subjected and not how it might be driven. How this dynamic coupling is effectuated is nonobvious and the entirety of the disclosure is directed to describing how it is done.

As stated in the balance of paragraph [005]:

> The overall dynamical system is comprised of three proof masses. The sense-direction oscillator is made up of the second and third masses, designed to amplify response in the sense-mode. The first mass and the combination of the second and third masses form the drive-direction oscillator. **The drive and sense-mode oscillators are mechanically decoupled**, minimizing instability due to dynamical coupling between the drive and sense modes. The frequency response of both of the drive and sense-mode oscillators have two resonant peaks and a flat region between the peaks. By designing the drive and sense antiresonance frequencies to match, the flat-region frequency band of the oscillators are overlapped, defining the nominal operation region of the device, where the response gain is less sensitive to parameter variations.

Paragraphs [006] – [020] provide thumbnail sketches that describe the structure and dynamic performance of a decoupled system. The Examiner's characterizations of mechanical couplings at paragraph 26 of the Office Action are irrelevant to the decoupling of drive and sense oscillations. The Examiner's statement regarding movement of the first mass in the drive direction causing movement of the second and third masses in the drive direction are similarly irrelevant to decoupling of drive and

sense oscillations. Similarly, attempts by the Examiner to confuse the sense and drive mode oscillators because the motions in the drive direction of the three masses are the drive oscillations and motions of two of the three masses in the sense direction are the sense oscillations misconstrues the disclosed invention. A conceptual distinction must be maintained between the masses and their respective motions.

In regard to paragraph 27 of the Office Action, with all due respect, the disclosure does teach that the motion of the sense mode oscillator in the sense direction is decoupled from the motion of the drive mode oscillator in the drive direction as explicitly set out in paragraph [005] above and implicitly in the mathematical descriptions of those motions throughout the Detailed Description. The parameter choices and relationships resulting in decoupling are clearly set out in great detail in the specification and claims.

In regard to paragraph 28 of the Office Action, claims 4, 10, 12, 14, 28 have been responsively amended to remove what amounts to misconstructions attributed to them. There is a drive means in the sense oscillator notwithstanding the Examiner's implicit contention to the contrary.

Paragraph [049] states:

> The second mass 18 oscillates in both x drive and y sense directions, and generates the rotation-induced Coriolis force that excites the sense-direction oscillator 14. The sense direction response of the third mass 20, which comprises the vibration absorber of the sense-mode oscillator 14, is detected for measuring the input angular rate.

The motion of mass 18 drives or excites the sense direction oscillator. The sense response is shown in the motion of mass 20 which acts as an absorber of the vibrations created by mass 18. The equations of motion of the gyro make this very clear.

In regard to paragraph 29 of the Office Action, the Examiner seems to contend

that there is no disclosure of amplification by virtue of the motions of the drive and sense oscillators. Paragraph [005] states:

> The sense-direction oscillator is made up of the second and third masses, designed to **amplify** response in the sense-mode.

Paragraph [006] states:

> Utilizing dynamical **amplification** in the sense and drive mode oscillators instead of resonance, increased bandwidth and reduced sensitivity to structural and thermal parameter fluctuations and damping changes are achieved.

Paragraph [008] states:

> The drive-mode oscillator and sense-mode oscillator utilize dynamical **amplification** in the drive and sense directions to achieve large oscillation amplitudes without resonance resulting in increased bandwidth and reduced sensitivity to structural and thermal parameter fluctuations and damping changes.

Paragraph [016] states:

> The second and the third masses combine to comprise a vibration absorber of the drive-mode oscillator, which vibration absorber mechanically **amplifies** the oscillations of the first mass.

Paragraph [017] states:

> The first mass is driven at a driving frequency, ω_{drive}, by means of a input force F_d, which driving frequency, ω_{drive}, is matched with the resonant frequency of an isolated passive mass-spring system comprised of the second and third masses and coupled flexures. The passive mass-spring system moves to cancel out the input force F_d applied to the first mass, so that maximum dynamic **amplification** is achieved.

Paragraph [018] states:

> The third mass acts as the vibration absorber in the sense-mode oscillator to achieve large sense direction oscillation amplitudes due to mechanical **amplification**.

Paragraph [019] states:

> A sinusoidal Coriolis force is applied to the second mass, whose frequency is matched with a resonant frequency of the isolated passive mass-spring system

of the third mass and its coupled flexures, so that the third mass achieves maximum dynamic **amplification**.

Paragraph [047] states:

In the illustrated embodiment, a micromachined gyroscope system 10 is disclosed that utilizes dynamical amplification in the decoupled drive oscillators 12 and sense oscillators 14 in order to achieve large oscillation amplitudes without resonance.

Paragraph [052] states:

The response of the combined dynamical system to the rotation-induced Coriolis force will have a flat region in the frequency band coinciding to the flat regions of the independent drive and sense-mode oscillators as depicted in the graph of Fig. 3(b). When the device is operated in this flat region, the oscillation amplitudes in both drive and sense directions are relatively insensitive to variations in system parameters and damping. Thus, by utilizing dynamical **amplification** in the oscillators instead of resonance, increased bandwidth and reduced sensitivity to structural and thermal parameter fluctuations and damping changes are achieved. Consequently, the design concept resulting in improved robustness and long-term stability over the operating time of the device is expected to relax control requirements and tight fabrication and packaging tolerances.

Paragraphs [090 - 093] state:

C. Parameter Optimization for Dynamic Amplification

Since the foremost mechanical factor determining the performance of the gyroscope is the sense direction deflection of the sensing element, mass 20, due to the input rotation, the parameters of the dynamical system should be optimized to maximize the oscillation amplitude of mass 20 in the y sense direction.

However, the optimal compromise between amplitude of the response and bandwidth should be obtained to maintain robustness against parameters variations, while the response amplitude is sufficient for required sensitivity. The trade-offs between gain of the response (for higher sensitivity) and the system bandwidth (for increased robustness) will typically be guided by application requirements.

For the purpose of optimizing each parameter in the dynamical system, the overall gyroscope system 10 can be decomposed into the drive-mode oscillator 12 diagrammatically depicted in Fig. 5(a) and the sense-mode oscillator 14 diagrammatically depicted in Fig. 5(b), analyzed separately below.

The following paragraphs to [094 - 114] address in detail the drive mode parameters, the sense mode parameters and the overall systems parameters which are needed to realize maximize the oscillation amplitude of mass 20 in the y sense direction.

What is disclosed how to drive the drive-mode oscillator and the sense-mode oscillator to dynamical amplify motion in the drive and sense directions to achieve large oscillation amplitudes without resonance to result in increased bandwidth and reduced sensitivity to structural and thermal parameter fluctuations and damping changes as per claim 16.

In regard to paragraph 30 of the Office Action, the Examiner incorrectly contends that there is no disclosure that the second and there masses oscillate independently from each other as per claim 18. Paragraph [010] states:

> The drive-mode oscillator and sense-mode oscillator include a drive means for driving a mass in a drive direction and a sense means for sensing motion of a mass in a sense direction. The three interconnected masses comprise a first, second and third mass. The first mass is the only mass excited by the drive means. The first mass oscillates in the drive direction and is constrained from movement in the sense direction. **The second and third masses are constrained from movement with respect to each other in the drive direction and oscillate together in the drive direction but oscillate independently from each other in the sense direction.** The third mass is fixed with respect to the second mass in the drive direction, but is free to oscillate in the sense direction. The first mass acts as a driven mass and the second and third masses act collectively as a passive mass to comprise the drive-mode oscillator. The second and third masses comprise the sense-mode oscillator.

Paragraph [048] states:

> The first mass 16 or m_1, which is the only mass 16 excited in the drive direction, which is here the x direction in Fig. 1, is constrained in the sense direction, which is the y direction in Fig. 1, and is free to oscillate only in the drive direction. The second mass 18 or m_2 and third mass 20 or m_3 are constrained with respect to each other in the x drive direction, thus oscillating as one combined mass in the x drive direction. **However, masses 18 and 20 are free to oscillate independently in the y sense direction, forming the sense-direction oscillator.** The first mass 16 and the combination of the second and third

masses 18 and 20 form the drive-direction oscillator 12, where mass 16 is the driven mass as diagrammatically depicted in Fig. 2.

In regard to paragraph 31 of the Office Action, the Examiner incorrectly contends that there is no disclosure for moving the third mass coupled to the second mass substantially only in the sense direction as per claim 20. Paragraph [012] states:

> The three interconnected masses comprise a first, second and third mass in which the first mass is anchored to the substrate by a first flexure which allows movement substantially only in the drive direction, in which the second mass is coupled to the first mass by a second flexure that allows movement in the drive and the sense directions, and **in which the third mass is coupled to the second mass by a third flexure which allows movement substantially only in the sense direction**.

In regard to paragraph 32 of the Office Action, the Examiner incorrectly contends there is no disclosure for claim 21. Claim 21 claims the schematic of Fig. 2. The first mass is mass 16. The second mass is mass 18. The third mass is mass 20. The first flexure is spring k_{1x}. The second flexure are springs k_{2x} and k_{2y}. The third flexure is spring k_{3y}. The springs are restrained mechanically to move only in the subscripted directions.

Applicants respectfully request advancement of the claims to allowance.

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